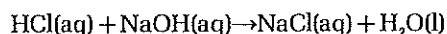
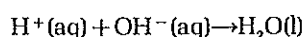


8.3 Heat of neutralization

The reaction between hydrochloric acid and sodium hydroxide is a typical example of neutralization.



This reaction can also be represented by an ionic equation, which shows the ions only.



Whenever this neutralization reaction takes place – whatever the acid or base – energy is always released. Neutralization of an acid with a base is always exothermic.

Aim

To determine the amount of energy produced from the reaction of an acid with an alkali.

Apparatus and materials

Measuring cylinder, 25 cm³

Thermometer, –10 to +110°C

Plastic cup

Sodium hydroxide solution, 2 mol dm^{–3}

Potassium hydroxide solution, 2 mol dm^{–3}

Nitric acid, 2 mol dm^{–3}

Hydrochloric acid, 2 mol dm^{–3}

Precaution

The alkalis are corrosive. Wash them off immediately if they get on the skin. Eye protection is essential.

Procedure

- 1 Use a measuring cylinder to pour 25 cm³ of sodium hydroxide solution into a plastic cup.
- 2 Measure the temperature of the sodium hydroxide solution.
- 3 Wash out the measuring cylinder and measure 25 cm³ of dilute hydrochloric acid.
- 4 Measure the temperature of the acid.
- 5 Calculate the average temperature of the acid and alkali.
- 6 Add the acid to the alkali and stir the mixture with the thermometer.
- 7 Record the highest temperature reached and calculate the temperature rise.
- 8 Wash out the plastic cup and repeat steps 1–7 with the other combinations of acid and alkali shown in the second results table.

Results

Copy and complete the following table:

volume of sodium hydroxide solution used	= 25 cm ³
volume of hydrochloric acid used	= 25 cm ³
temperature of sodium hydroxide solution	= °C
temperature of dilute hydrochloric acid	= °C
average temperature	= °C
highest temperature reached	= °C
rise in temperature	= °C

Complete three more tables for the other combinations of acid and alkali.

Summarize your results by copying and completing the following table:

acid	alkali	temperature rise/°C
hydrochloric acid	sodium hydroxide	
hydrochloric acid	potassium hydroxide	
nitric acid	sodium hydroxide	
nitric acid	potassium hydroxide	

Extra work

- Use a burette to add 1 cm³ of acid at a time to the alkali and measure the temperature rise after each addition. Plot a graph of temperature rise against volume of acid added.

Questions

- 1 a) Why is a plastic cup used rather than a glass beaker?
b) Why must the solution be stirred?
c) How would you modify the experiment if dilute sulphuric acid were used? Note that sulphuric acid has the formula H₂SO₄.
d) How would the temperature rise be affected if the concentrations of both solutions were halved?
e) How would you modify the apparatus to reduce heat loss?